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The effect of satellite and conventional meteorological data assimilation on the mesoscale modeling of monsoon depressions over India

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With 17 Figures

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Summary

The Fifth Generation Mesoscale Model (MM5) is used to study the effect of assimilated satellite and conventional data on the prediction of three monsoon depressions over India using analysis nudging. The satellite data comprised the vertical profiles of temperature and humidity (NOAA-TOVS: – National Oceanic and Atmospheric Administration-TIROS Operational Vertical Sounder; MODIS: – MODerate resolution Imaging Spectroradiometer) and the surface wind vector over the sea (QuikSCAT: – Quick Scatterometer); the conventional meteorological data included the upper-air and surface data from the India Meteorological Department (IMD). Two sets of numerical experiments are performed for each case: the first set, NOFDDA (no nudging), utilizes NCEP reanalysis (for the initial conditions and lateral boundary conditions) in the simulation, the second set, FDDA, employs the satellite and conventional meteorological data for an improved analysis through analysis nudging. Two additional experiments are performed to study the effect of increased vertical and horizontal resolution as well as convective parameterization for one of the depressions for which special fields observations were available. The results from the simulation are compared with each other and with the analysis and observations. The results show that the predicted sea level pressure (SLP), the lower tropospheric cyclonic circulation, and the precipitation of the FDDA simulation reproduced the large-scale structure of the depression as manifested in the NCEP reanalysis. The simulation of SLP using no assimilation high-resolution runs (HRSKF10KM, HRSKF3.3KM) with the Kain-Fritsch cumulus parameterization scheme appeared poor in comparison with the FDDA run, while the no assimilation high-resolution runs (HRSGR10KM, HRSGR3.3KM) with the Grell cumulus scheme provided better results. However, the space correlation and the root mean square (rms) error of SLP for the HRSKF10KM was better than the FDDA; the largest and smallest space correlation for HRSKF10KM, FDDA, and HRSGR10KM were 0.894 and 0.623, 0.663 and 0.195, and 0.733 and 0.338 respectively; the smallest and largest rms error for HRSKF10KM, FDDA and HRSGR10KM were 1.879 and 5.245, 2.308 and 4.242, and 2.055 and 4.909 respectively. The precipitation simulations with the 3.3 km high-resolution, no assimilation runs performed no better than the precipitation simulation with the FDDA run. Thus, a significant finding of this study is that over the Indian monsoon region, the improvements in the simulation using nudging in the FDDA run are of similar magnitude (or better) than the improvements in the simulation due to high-resolution and to cumulus parameterization sensitivity. The improvements in the FDDA run due to analysis nudging were also verified in two more depression cases. The current operational regional models in India do not incorporate the

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